NOTES ON THE FEEDING OF NORMAL INFANTS

THE CHILDREN'S DEPARTMENT,
THE LONDON HOSPITAL, E.1

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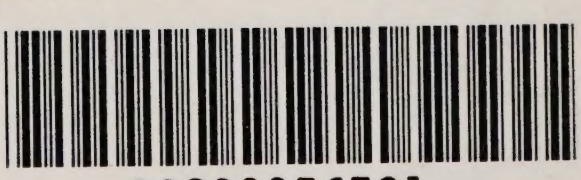
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NOTES ON THE FEEDING OF NORMAL INFANTS

An adequate diet in infancy, as at any other age, must be considered from the point of view of (1) the total caloric requirements of the organism, (2) the total fluid requirements, (3) the balance between the food substances—fat, protein, and carbohydrate, and (4) the presence of mineral constituents and accessory food factors (vitamins).

In infancy the total caloric intake must be such as to allow not only for maintenance and activity but for growth and normal gain in weight. The last of these is relatively more rapid during the first six months than during any subsequent period, and, therefore, although the total food requirements will increase with age until adult life, the caloric requirements per pound body weight will be highest during the first six months. Calculation from the metabolism and food intake of a large number of normal infants shows the caloric requirements per pound body weight to be between 45 and 50 during this period, and this should be taken as the first standard in making up a feed. Underweight infants require a higher caloric intake.

The relative proportions of protein, fat, and carbohydrate in the diet may be varied within wide limits, and though human breast milk is unquestionably the ideal diet for the human infant, it is neither necessary nor possible to modify cow's milk, for the

purpose of artificial feeding, so that it is of exactly the same constitution. Human breast milk contains an average of protein 1·25 per cent., fat 3·5 per cent., carbohydrate (lactose) 7·5 per cent., mineral salts 0·2 per cent., and water 88 per cent. The protein in the diet should not be less than this percentage, as it cannot be synthesised from either of the other food substances and is essential for life and growth. With regard to fat and carbohydrate, it may be said that a diet which is high in *both* these constituents tends to cause gastro-intestinal upsets. Fat provides half the calories of breast milk (the caloric value of 1 gram of fat being 9·3 as compared with 4·1 of both protein and carbohydrate). It is also important in the dietary for the provision of the fat-soluble vitamins A and D, but if these are otherwise supplied in concentrated form and the necessary calories made up with protein and carbohydrate, infants are able to do well, for a time at least, on a low fat dietary. Carbohydrate is well tolerated by the majority of infants, and serves to spare protein to some extent, but excessive amounts given over a long period tend to produce a fat, flabby infant with poor resistance to infection.

When cow's milk is substituted for breast milk, a somewhat higher percentage of total protein must be given, since the proportion of lactalbumin (which is especially rich in essential amino-acids) is much lower in cow's milk than in breast milk ; thus whilst breast milk contains lactalbumin and casein in the proportion of 2 : 1, in cow's milk protein the proportion is only 1 : 6. The infant's minimum protein requirements will be covered by 1½ oz. cow's milk per pound body weight daily, and the amount given should never fall below this figure.

The fluid requirements of the normal infant are from 2 to $2\frac{1}{2}$ oz. per lb. of body weight daily. This amount may have to be increased when for any reason there is increased fluid loss (e.g. in hot weather). It is important to remember that if under these circumstances a baby is exceptionally thirsty and the only fluid it is offered is breast milk, it is very liable to take more food than it requires or can tolerate.

Breast Feeding.

It cannot be too strongly emphasised that, during the earlier months of infancy at any rate, breast feeding is the ideal method and should not be abandoned unless circumstances make this essential. It is often urged that many artificially fed babies are reared successfully in every way, but the fact remains that in general breast-fed babies are slightly better nourished and developed, and considerably less liable to infection and gastro-intestinal upsets than bottle-fed babies. Not only is human breast milk a food of the ideal composition for the human infant, but it is apt to be cleaner—passing direct from producer to consumer—and probably contains immune-bodies having an important anti-infective function. If the technique of breast feeding is carefully carried out, the number of mothers who are really "unable" to breast-feed their babies, for several months at least, will be found to be very small. The baby with whom breast milk really "doesn't agree" is certainly an extreme rarity. The only one absolute contra-indication to breast feeding is active pulmonary tuberculosis in the mother, but advanced carditis, diabetes, and insanity may render it impracticable.

It is a truism that the technique of successful breast feeding begins in the prenatal period. This should consist both in the instruction of the mother with regard to the advisability of breast feeding, and in preparation of the breasts for its successful carrying out. Daily sponging of the breasts and brisk rubbing of the nipples with a soft brush or turkish towel to harden them should be carried out in all cases for at least a month before delivery, while retracted nipples should be drawn out during this period. Retracted nipples are a frequent cause of inability to breast-feed. Drawing out the nipples must be done gradually, the skin and breast tissue being stretched with the thumbs horizontally away from the nipple, and the latter pressed forward. Lanoline should be applied to facilitate the process ; spirit is contraindicated.

Lactation is established at a variable time after parturition, but usually occurs in the course of the first week. The infant should, however, he put to the breast 6-hourly during the first 24 to 36 hours. This both stimulates breast secretion and provides the infant with colostrum, a substance probably rich in immune-bodies and serving as a highly concentrated food. Subsequently a 3- or 4-hourly routine should be instituted. In all new-born infants, and especially during hot weather, it is wise to give water or normal saline by bottle, ½ oz. after feeding, during the first 4 to 5 days, to compensate for such fluid loss as may occur. It is physiological for breast-fed babies to lose weight during this period, while lactation is being established, and in large babies the loss may be considerable. The birth weight should, however, be regained by the end of the first 10 days of life. It is useful to " test-feed "

(i.e. to weigh before and after each feed), for at least four feeds, on the sixth day, to determine the average amount of breast milk that is being obtained at each feed. The quantity of breast milk secreted is closely proportional to the demand. Thus the stronger stimulation of a lusty 10-lb. baby will result in a considerably greater secretion than that of a premature infant, and similarly the great majority of normal women are well able to nurse twins or even triplets if the call arises.

The average composition of breast milk has already been given. Of the food elements lactose is the most and fat the least constant. It is usually stated that the proportion of fat is highest in the last portion of the feed, and in the morning feeds. The first morning feed yields the largest quantity of milk. The vitamin content of the milk will depend on the diet of the mother, which should be considered from this point of view. The mother's diet should include a pint of milk a day, fresh fruit and vegetables, some whole-meal bread, and a liberal supply of protein. The importance of a sufficient fluid intake is obvious.

Nursing is best carried out with the infant comfortably supported in the crook of the elbow. At first the infant will usually be fed lying horizontally, but the semi-upright position is preferable, as it aids regurgitation of air. It is essential that the mother herself should be comfortable during nursing, and for this purpose a low nursing chair should be used in which she can sit with both feet firmly on the floor and the weight of the child supported partly on her knee. During the first ten days she will be in bed, but as soon as possible she should nurse sitting up and leaning slightly forward. One hand must be

kept free to support the breast, direct the nipple if necessary, and keep the breast tissue from occluding the infant's nose. Large and pendulous breasts make this particularly necessary, so that the infant is able to breathe normally during suckling.

The number of feeds given in the day will depend to some extent on the size and strength of the infant. As a working rule it may be said that an infant weighing 6 lb. or over at birth may be put at once on to the 4-hourly schedule, viz. 6 a.m., 10 a.m., 2 p.m., 6 p.m., and 10 p.m. In the case of feeble infants a night feed may be given at 2 a.m., but as this is a considerable added strain on the mother it is desirable to discontinue it as soon as possible. Premature infants and those weighing less than 6 lb. will require 3-hourly feeding, viz. 6 a.m., 9 a.m., 12 noon, 3 p.m., 6 p.m., 9 p.m., and 12 midnight; but here again the 12 p.m., feed should be discontinued as soon as reasonably possible, and the schedule changed to the 4-hourly one. In the case of very small premature infants 2-hourly feeding may be necessary. It is most important that feeding should be regulated by the clock; the baby should be wakened for his feed if asleep, and never given anything except perhaps water if he wakes before his feeding time. A regular sleep-and-feeding rhythm is readily developed and equally easily broken in early infancy.

As a general rule it is advisable to give both breasts at each feed, when 4-hourly feeding is adopted, alternating the breast that is given first. Ten minutes on each breast is always sufficient, since in the case of a small feeble baby a longer period will simply tire the infant, while in the case of a large

hungry baby it will lead to over-feeding or air-swallowing. In the former case, if insufficient milk is obtained in 20 minutes, the remainder should be expressed by hand and given by spoon. A baby should never be allowed to go to sleep during a feed. While the giving of both breasts at each feed as above described is to be advocated in 4-hourly feeding (since the maximum secretion of milk will be obtained by stimulation of the breast five times in the 24 hours), the giving of a single breast alternately at each feed has its advocates on the grounds that the breast is, in this way, more completely emptied —an important point in maintaining secretion—and that no fat is lost. This practice may usefully be adopted in the case of 3-hourly feeding, or in cases where the infant is getting too much milk from the two breasts at each feed. In the feeding of twins it is best to feed one baby on each breast at each feeding time, changing the babies round at each feed to ensure equal stimulation.

If circumstance arise (such as the admission of an infant to hospital, or inability to suckle on account of feebleness) rendering it desirable to maintain lactation artificially, this may be done by manual expression of breast milk or by pumping the breast mechanically. It is probably wise in the case of all small infants to strip the breast completely by these means after suckling is completed. Manual expression should be carried out in two stages : (1) gentle effleurage from the periphery of the breast towards the nipple, and (2) rhythmic lateral pressure of the areola towards the nipple carried out in the plane of the skin surface by the finger and thumb. It is essential that the whole process should be carried out gently to avoid damage to the breast tissue and

the possible complication of breast abscess. Only the complete and regular emptying of the breasts will bring about satisfactory milk secretion.

Complementary feedings (i.e. an artificial feed given after one or more breast feeds) will be necessary when the supply of breast milk is found by a series of test weighings to be insufficient for the infant's needs. It should be remembered, however, that the best stimulus to increased breast secretion is the sucking of a hungry infant, and also that an infant will tend to prefer the easier method of obtaining milk from the bottle if given the opportunity. Complementary feeds should only, therefore, be given when really necessary ; they should be given by spoon and should be unsweetened. It is usual to complement the 2 p.m. or 6 p.m. feeds for preference, as the supply of breast milk tends to be least at these times.

Supplementary feeds (i.e. the complete substitution of one or more artificial feeds for the corresponding breast feeds) may be given when, for instance, the mother has to work during the day or when weaning is being gradually carried out. Many mothers will consent to continue with two or more breast feeds throughout the period of nursing when they would feel complete nursing was entirely impracticable.

Underfeeding and failure to gain weight adequately on the breast are much more frequently due to faults of suckling and management than to any inherent deficiency of either quantity or quality of breast milk. Certain infants are "breast shy," and instead of settling down to suckling in a business-like way, will continually cry and let the nipple slip from the mouth. The utmost patience and the

constant expression of drops of milk by the mother into the infant's mouth are necessary in these cases. and particular care should be taken that the infant is comfortably held, is dry, can reach the breast without undue straining, and that the breast is supported to prevent smothering the face. It may be found that a small dose (e.g. m. v) of syrup of chloral 20 minutes before the feed will be all that is required to ensure peaceful suckling. If there is any nasal obstruction—either from mucous secretion or congenital adenoids—this should receive attention. In the former case the nose should be wiped clean with a small pledget of soft wool, and a small amount of liquid paraffin or vaseline applied.

A placid attitude on the part of the mother is also essential for successful nursing, and over-anxiety on her part is often the chief difficulty with which to contend. If reasonably possible, the mother is well advised to lie down for a short rest before each feed.

The question of preparation of the breasts during pregnancy has already been mentioned ; hardening of the nipples by application of spirit is to be deprecated, as it frequently leads to cracking of the skin. Absolute cleanliness, careful drying, and if necessary the application of lanoline after suckling are the best preventives of *cracked nipples* ; if this latter condition occurs, a rubber nipple shield should be employed at once, as the cracks are difficult to heal and extremely painful if direct suckling is allowed. The application of Tinct. Benzoin Co. is valuable. It is seldom necessary to take the infant completely off the affected breast—and, indeed, this is most undesirable on account of the painful engorgement which follows. For a short period, however, it may

be necessary to suspend nursing from the affected breast during which time the milk should be removed from the breast at regular intervals by expression. *Breast abscess* is a more serious condition which may result from infection of a cracked nipple or from trauma. Blocking of a duct with constant stagnation of milk is also an important factor in producing an abscess. When this occurs, it will be necessary to feed the infant on the normal breast entirely until the abscess has been dealt with. Fomentations should be employed for 24–48 hours, a hole being cut in the lint so that the nipple is left free. The breast should also be firmly supported and *light* massage over the affected area, in the line of the duct from the periphery to the nipple, should be carried out two or three times daily so as to free, if possible, any blocking of the ducts. Surgical intervention may, however, become necessary. Unless the mother is seriously debilitated, it is unnecessary either to wean the infant completely or to complement more than one or two breast feeds each day. It will be found that if secretion is maintained in the unaffected breast, it can be re-established with surprising rapidity and success in the affected breast after healing has taken place. Suckling at the unaffected breast does not prevent healing of the abscess in the other.

Occasionally it will be found that in spite of careful attention to the management of nursing, and willingness on the part of the mother to carry it out, an inherent deficiency of milk secretion exists. It is not justifiable to assume this from the size of the breast, as frequently a small breast will secrete better than a large pendulous one ; nor should too

much attention be paid to the story that a mother could never feed her previous children. In such cases, and more particularly in those showing a diminution in secretion during the nursing period, stimulants to secretion, such as massage, hot and cold sponging of the breasts, increased fluid intake, and complete emptying of the breast by manual expression or breast pump, should be applied in addition to the one essential stimulus—viz. the regular and vigorous sucking of a healthy infant. The mother's general health should, of course, be attended to. In order to meet the infant's requirements in cases of deficient secretion of breast milk, resort should be made to complementary and not supplementary feeding.

Overfeeding is one of the commonest causes of disturbance in the breast-fed infant. While the drooling of a drachm or so of milk is a normal occurrence when " the wind is brought up " after feeding, regurgitation of considerable quantities of unaltered milk should lead to suspicion of overfeeding. Confirmatory evidence is given by the occurrence of frequent loose stools and a gain in weight of over 8 oz. per week, and finally by test feeding. Overfeeding is met by giving $\frac{1}{2}$ to 1 oz. of water *before* the feed (so that the infant goes to the breast feeling less hungry), by increasing the interval to 4 hours if the infant is being fed 3-hourly, by using one breast if two are being employed at each feed, and by feeding the infant for a shorter period (e.g. 7 or even 5 minutes on each breast instead of 10).

Constipation is somewhat of a bogey in breast feeding. It is usual for the breast-fed infant to have less frequent stools than the bottle-fed, and as

long as the stools are of soft consistency, do not cause undue straining, and are yellow in colour, little harm is likely to result even if a stool is not passed daily. Liquid paraffin (with orange juice) may be used as an intestinal lubricant, or 1 to 2 teaspoonfuls of stewed prune juice each morning as a mild laxative. As a rule, a drachm of extract of malt two to three times daily gives excellent results. In obstinate cases the use of a bougie inserted into the anal canal may be necessary to establish a regular habit.

Diarrhœa may be due to either over- or under-feeding, and such faults should be investigated and corrected. Too rapid feeding by a hungry baby will give much the same picture as overfeeding, and is an indication for water before the feed and control of the milk supply by gentle pressure on the nipple areola during feeding. Inanition diarrhœa is characterised by the passage of very small, frequent green " hunger stools." True " summer diarrhœa " and diarrhœa secondary to infection will not be considered here.

Weaning should be carried out gradually between the seventh and ninth month and should take approximately 4 weeks. It is inadvisable, however, to start weaning during hot weather—when the infant is particularly liable to gastrointestinal upsets—or during illness. In the case of 4-hourly feeding (five feeds), one breast feed should be discontinued every 6 days, the early morning feed being retained the longest. Undiluted cow's milk may be given from the cup or by spoon, and one feed of oatmeal or pulped baked apple and a little green vegetable after the age of six to seven months.

Artificial Feeding

The vast number of patent foods on the market has made rational artificial feeding appear considerably more difficult than it really is. It is essential to keep in mind the food requirement of the normal infant (which has been previously discussed) and both the caloric value and composition of the food used. The caloric value of 1 gram of each of the principal food-stuffs, fat, protein, and carbohydrate is 9·3, 4·1, and 4·1 respectively. Thus if the percentage composition of a food is known, the caloric value can be calculated. In most cases, however, this is either given on the tin or can easily be remembered. Thus both human and cow's milk have a caloric value of 20 calories to the fluid ounce. The great majority of " full cream " and " humanised " dried milks on the market are so standardised that 1 drachm of the powder with 1 oz. of water makes 1 oz. of whole milk. Each has a caloric value of approximately 20 calories to the drachm of powder, or 20 calories to the fluid ounce when this has been reconstituted with water. " Half-cream " milk corresponds to cow's milk from which 2 oz. of cream have been skimmed off the pint, and " skimmed " from which 4 oz. have been taken. They contain 2 and 0 per cent. fat respectively. In calculating from the metric to the British standards, it may be taken that 1 fluid ounce is approximately 30 c.c. and that 1 oz. by weight is approximately 30 grams. The greatest error is likely to occur when measurements are made in spoonfuls. Thus 2 tablespoonfuls of fluid measure from 1 to $1\frac{1}{2}$ oz. (more usually the latter), according to the size of the spoon, and it is frequently found that a feed which is theoretically

admirable is actually considerably too dilute owing to a 50 per cent. error in measuring the fluid. Similarly a " heaped teaspoon " for a drachm is liable to great inaccuracy, and it is best, if a teaspoon is used for measuring dried milks, to prescribe " 2 *level* teaspoonfuls " of a spoon of standard size as the equivalent of a drachm. (Most makers of dried milks supply a drachm measure with the milk.) One level teaspoonful of sugar, on the other hand, on account of its greater density, weighs just over 1 drachm.

Cow's Milk Feeding. Although the milk supply of our large cities is for the most part excellent, it should be emphatically stated that it is still unsafe from the point of view of tuberculous and other infection to give raw cow's milk to infants under 5 years of age. There is no contraindication to this procedure, and it has the advantage that the curd is thereby rendered more easily digestible.

Vitamin Requirements. Infants who are artificially fed will need the addition of vitamines to their food. The essential vitamines required are contained in cod-liver oil and orange juice, and these should be introduced into the diet at the end of the first month. The initial dose of cod-liver oil is five minims twice daily. This dose should be gradually increased so that at six months of age the infant should receive a drachm of cod-liver oil three times a day. Orange juice should also be given from the second months onwards. The initial dose is a drachm, and the amount given is to be gradually increased so that half an ounce a day is taken when the infant is six months old.

There are now three varieties of milk on the market :—

Tuberculin-Tested Milk. This grade replaces the old " Certified " and " Grade A (Tuberculin-tested) " milks. This milk may be pasteurized; when this has been done it must be sold as " Tuberculin-tested Milk (Pasteurized)." If this grade of milk is bottled on the farm it can be sold under the designation of " Tuberculin-tested Milk (Certified)."

Accredited Milk. This term is now applied to the milk which was formerly sold as " Grade A." The use of this term is unfortunate, as such milk cannot be accepted as safe and therefore should be boiled before consumption.

Pasteurized Milk. This term is to be applied to all milk which has been held at a temperature of 145° to 150° for thirty minutes. For practical purposes this milk is the most suitable wet milk for infant feeding.

Cow's Milk Dilutions and Formula Feeding. Where feeding is being carried out under relatively clean home conditions and a good milk supply is available, cow's milk is the most economical form of artificial feeding. Undiluted raw milk, however, is not a suitable feed for infants under 6 months of age. A comparison of the percentage composition of human and cow's milk will make this clear :

	Human.	*Cow's.*
Fat	3·5	4·00
Protein . . .	1·25	3·50
Carbohydrate (lactose)	7·5	4·50
Mineral salts . .	0·20	0·70
Water . . .	88	86–87
	20 cals. per oz.	20 cals. per oz.

It will be seen from the above that while the protein and salt content of cow's milk is approximately three times that of breast milk, the carbohydrate (lactose) content is considerably lower. Not only is the total protein content of the two milks different, but in human milk the protein is composed of lactalbumin and casein in the proportions of 2 : 1, whereas in cow's milk they are present in the proportions of 1 : 6. The importance of this has already been mentioned. As casein is the substance responsible for curd formation, the cow's milk clot tends to be tougher and less digestible than that of human milk. This is the chief cause of digestive disturbances caused by whole milk ; indigestion due to protein *per se* is rare, if it occurs at all. It will be logical, therefore, to attempt to modify the clot by dilution of cow's milk with water, and as the infant's protein requirements are supplied by $1\frac{1}{2}$ oz. of cow's milk per lb. body-weight and its fluid requirements are about $2\frac{1}{2}$ oz., dilution may be made in the proportion of approximately $1\frac{1}{2}$ oz. cow's milk to 1 oz. water. In this dilution the fat and carbohydrate content will be relatively low, and so in order to raise the caloric value per ounce of the mixture, carbohydrate is added in the form of cane sugar of dextrimaltose. (Lactose has no advantage over cane sugar and is more expensive.) It is a useful working rule that not more than one-third the total calories should be given as added carbohydrate.

An example will make this clear. It is required to make a formula for the feeding of a 10-lb. baby (age approximately $2\frac{1}{2}$ months).

(1) The baby will require a total of 450 calories (45 per lb. body-weight) in the course of the day.

(2) He will require $1\frac{1}{2}$ oz. cow's milk per lb. of body-weight a day (viz. 15 oz.) to supply his protein requirements. As cow's milk has a caloric value of 20 cals. per oz., this will supply 300 cals. (15×20).

(3) One-third the total (450) cals. is supplied as added carbohydrate, viz. 150 cals. As carbohydrate has a caloric value of 120 per oz., this will represent $1\frac{1}{4}$ oz. sugar. In other words, the infant is given 1 drachm of added carbohydrate per lb. of body-weight a day.

(4) The fluid is increased by the addition of 1 oz. water per lb. (10 oz.) to make a total of $2\frac{1}{2}$ oz. fluid per lb. body-weight daily.

Thus, the total food supplied for the day will be :

Cow's milk ($1\frac{1}{2}$ oz. per lb.)	15 oz.	300 cals.
Water	10 oz.	
Sugar	$1\frac{1}{4}$ oz.	150 cals.
	25 fluid oz.	450 cals.

As the baby will be receiving five feeds in the day, this will mean that each feed consists of 5 oz. of the mixture (25 oz. $\div$ 5 feeds).

It is often a convenience to use the following standard formula, which provides a mixture having a caloric value of 20 cals. per oz. :

Cow's milk . . .	12 oz.	300 cals.
Water	6 oz.	
Sugar	1 oz.	120 cals.
	18 fluid oz.	360 cals.

The infant is given as many ounces of this formula at each feed as are required by its body-weight. Thus an 8-lb. baby will require $8 \times 45 = 360$ cals. in the

day, or 360 ÷ 5 = 72 cals. at each of 5 feeds. This will be supplied at each feed by approximately $3\frac{1}{2}$ oz. of a mixture having a caloric value of 20 cals. per oz.

Certain qualifications of this method are necessary. It will be found that some infants cannot tolerate feeds of quite as large a volume as those giving $2\frac{1}{2}$ oz. fluid per lb., and in these cases the water content must be reduced. The total fluid should not be less, however, than 2 oz. per lb. of body-weight daily. In new-born babies it may be necessary further to dilute the milk (as much as 1 part of milk to 1 part of water) for the first 2 weeks to avoid curd-indigestion, and after 4 months of age the dilution is decreased until the baby is receiving whole cow's milk at 6 months. The added carbohydrate may be discontinued at this time. At no age should a mixture more dilute than equal parts of milk and water *ever* be employed.

Dried Milks. On account largely of simplicity and cleanliness, dried milks have become very widely used in this country. They have the additional advantage that the curd is rendered more digestible in the process of their preparation. They are prepared in one of two ways. (1) The " roller " process in which fresh milk is poured on to hot rollers, the fluid thus being evaporated and the solid constituents forming a fine film on the rollers. (2) The " spray " process in which the milk is forced, while hot, through fine jets, the water evaporating and the solids falling to the floor of the preparation chamber. The vitamin content with regard to A and D is relatively little reduced, but it is important to supply orange juice to make up deficiency in vitamin C. The unmodified dried milks are usually

sold in a form in which 1 drachm of the powder with 1 oz. of water makes 1 oz. of cow's milk. The " drachm " may either be weighed, or measured with the standard measure supplied with the tin ; the fallacies of ordering by spoonfuls have already been mentioned. Many brands of dried milk (e.g. Cow and Gate) are also obtainable in " half-cream " (i.e. 2 per cent. fat in the reconstituted milk) and " skimmed " preparations in addition to the full-cream preparation. In infant feeding, these dried milks are used in exactly the same way as the corresponding type of cow's milk, it being remembered that 1 part dried milk to 8 parts water reconstitutes the milk from which it is prepared. It should be remembered, however, that on account of their greater digestibility they can be used in greater concentration than can fresh cow's milk. Half-cream milk is suitable for very young infants, of those who are intolerant of fat, and skimmed milk for cases of gastro-intestinal upset. It is unnecessary to use skimmed milk in the feeding of normal infants.

Condensed Milks. These are manufactured by heating fresh cow's milk and evaporating, *in vacuo*, about half the water content of the milk being retained. " Unsweetened " condensed milks can be used in the same way as cow's milk after making up with the corresponding amount of water. " Sweetened " condensed milks, however, differ completely in composition, as large amounts of cane sugar are added as a preservative and the undiluted preparation has a caloric value of 98·7 cals. per oz. (as compared with 49·1 cals. per oz. of the unsweetened undiluted milk). The sweetened condensed milks are completely unsuitable for the feeding of

normal infants, owing not so much to their high carbohydrate percentage but because of their deficiency in fat and protein. They may occasionally be of value in the (temporary) feeding of premature babies where it is required to give a relatively high caloric feeding for the first week or two of life.

Modified Milks. The general principles of cow's milk modification by dilution and the addition of carbohydrate have already been discussed. There are various other methods of modification, however, which also have their uses and advocates. The so-called "*humanisation*" of cow's milk, a type of "percentage feeding," represents an attempt to produce a modification of cow's milk having the same percentage composition and caloric value as human breast milk. This is done by dilution of cow's milk (to reduce the total protein content) and the addition of carbohydrate and fat (in the form of cream, 50 per cent. cod-liver oil emulsion, or one of the proprietary preparations such as Vitoleum). A formula of this type, having a composition of sugar 7·3, fat 3, protein 1·3, is :

Cow's milk .	12 oz.
Lime water .	1½ oz.
Sugar . .	2 level tablespoonfuls and 2 level teaspoonfuls.
Emulsion .	6 teaspoonfuls.
Water . .	13 oz.

The obvious disadvantages of such a formula are that it takes no account of the relative amounts of casein and lactalbumin in the protein content of cow's and human milk respectively, and that it is generally too complicated for out-patient use.

A number of firms, however, supply humanised dried milks which are as easy to use and in every way as satisfactory as the unmodified cow's milk preparations. An example is Humanised Trufood. No form of "percentage feeding" is peculiarly advantageous; it is, in fact, unnecessary in infant feeding.

Acid Milks. The addition of either lactic acid or hydrochloric acid to cow's milk results in the production of a finer curd. Whole lactic acid milk is prepared by the addition of lactic acid (B.P. 87·5 per cent.), drop by drop, stirring all the time, to milk which must be cold, in the proportion of 1 drachm to 1 pint of milk. The advantages claimed for this modification are that milk can be fed to young infants without dilution, thus insuring an adequate caloric intake. Further, the presence of acid in the milk overcomes the buffer substances present, and has a mildly anti-bacterial action. Sugar should always be employed as an addition to acidified milk, usually in the proportion of 1 oz. to the pint. Each feed should be heated in the bottle to no more than about 100 degrees Fahrenheit, and the hole of the teat should be relatively large.

Alkalis (particularly lime water and sodium citrate) have been employed to modify curd formation and render the milk more easily digestible. Sodium citrate is aded in the proportions of 1 to 2 grains per oz. whole milk, or lime water in the proportion of 5 to 10 per cent. of the mixture. They have little advantage over acids in this respect, and several disadvantages that the former do not possess. They are better avoided.

Peptonisation, or partial digestion of milk, is sometimes employed in the case of very young or

feeble infants, but is usually quite unnecessary. It is carried out by the use of peptonising powders.

Whey is prepared by the artificial clotting of milk and the removal of the curd. It is unsuitable as a food, as it contains only 0·82 per cent. protein, 0·25 per cent. fat, and 4·65 per cent. carbohydrate, but used at one time to be recommended for premature infants owing to its low casein content. It is valuable as a diluent for cow's milk, but its use is generally unnecessary.

Buttermilk is that portion of the milk remaining after the removal of the butter, and is characterised by being low in fat (0·6 per cent.) and relatively low in carbohydrate (3·9 per cent.). It is a better balanced food than whey, but the caloric value is low. The high protein (3·2 per cent.) and low fat render it a suitable food in cases of fat intolerance and diarrhœa.

Protein Milk contains a high protein-carbohydrate ratio, and can be simply prepared by the addition of water to one of the proprietary dried protein milk powders now available. Or alternatively it may be prepared by the addition of curds to buttermilk without the addition of water. It is of value in cases of diarrhœa, the indications for its use being similar to those for buttermilk. A skimmed milk powder reconstituted by the addition of 1 drachm of the powder, to $1\frac{1}{4}$ ounces of water with lactic acid (B.P. strength) in the proportion of 1 drachm to each pint of the mixture results in a preparation similar to buttermilk and can be used as a substitute for it. Neither buttermilk nor protein milk is necessary in the feeding of normal infants.

Infant Foods. Various infant foods, such as Mellin's, Benger's, Robinson's Patent Groats and Barley, etc., as distinct from simple dried or condensed milks, are widely advertised and are often employed. In themselves they usually constitute an ill-balanced diet, and when made up with milk fulfil little more or less than the rôle of added carbohydrate. Such a result can be achieved as easily and more economically by employing a simple gruel or cereal mixture, examples of which are given in the Appendix.

The Feeding of Premature Infants.

This subject presents a somewhat different problem from that of infants born at term. Not only is the premature's capacity for food intake and ability to suck less than the normal, but it is sometimes found that a larger number of calories per pound are necessary to cause gain in weight. While breast milk is unquestionably the food of choice, it may have to be artificially expressed and fed by spoon, by dropper, or by tube until the infant is strong enough to be suckled; also it will frequently be found that it is not possible at first to get the infant to retain enough of this food—having a caloric value of 20 calories to the oz.—to gain weight. Although the caloric needs of a premature infant are probably higher than those of a normal infant, it is neither desirable nor necessary to satisfy these in the first few weeks of life. Feeding should be carried out every 3 hours throughout the 24-hour period; in the case of exceptionally small infants, 2-hourly feeding may at first be necessary. If artificial feeding is adopted (and this should never be done in the case of prematures unless

absolutely unavoidable), concentrated sweetened condensed milk formulas or lactic acid milk with sugar may be used with advantage during the first 2 to 3 weeks of life on account of their high caloric value. Premature babies are particularly liable to develop rickets (even when breast-fed), and for this reason should be given small quantities of cod-liver oil (e.g. m. xx) or radiostoleum m. ii b.d. from the age of 1 month. It has recently been shown that premature infants are peculiarly liable to develop nutritional anæmia, and it is therefore a wise precaution to prescribe iron in the form of iron and ammonium citrate, grains ii to v o.d., from the second to the ninth month.

The management and general care of the premature infant is, of course, of paramount importance.

Mixed Feeding of Infants from 6 Months to 2 Years

As soon as an infant is beginning to cut his first teeth (usually about the age of 6 months) he should be given a rusk, or crust baked in the oven, to chew on. He will eat very little of it at this age, but it serves to accustom him to the taste and feel of food other than milk. At 6 months one feed of cereal or pulped stewed apple should be given in place of the 10 a.m. feed, and at 7 months vegetable purée, 2 oz., before the 2 p.m. feed ; a further cereal feed can now be added instead of plain milk. It is almost invariable for an infant to show distaste for a new food when it is first given, and for this reason it is important to make additions to the diet gradually, one at a time, and to persist with any given food until it is taken readily. Whole milk still forms the basis of the diet. If the infant is breast-fed, weaning should be begun

at about 7 to 8 months (substituting one bottle feed first for the 10 p.m. feed, then for the 6 p.m. feed, working backwards), until it is complete at 9 months. No useful purpose is served by continuing breast feeding after this time, except possibly during the course of an acute illness when weaning is inadvisable. At about 1 year the number of feeds should be reduced to four, and at about 15 months to three feeds daily. From 9 months of age the use of the bottle should be discontinued and the milk given from a cup. After 10 months of age additions to the diet are made more rapidly. It is important to keep the diet well balanced and avoid the usual fault of adding carbohydrate at the expense of protein ; the caloric requirements of the infant are about 40 per lb. during the second year. The following is a suitable type of dietary :

Diet from Nine Months to One Year

(Caloric value approx. 975 cals., protein 14·7 per cent., fat 38 per cent., carbohydrate 46·1 per cent.)

6 a.m.	7 oz. (14 tablespoonfuls) of milk.
10 a.m.	1½ oz. (3 tablespoonfuls) of porridge. ½ a lightly cooked egg (four mornings a week). ½ slice of bread fried in bacon-fat or dripping (3 mornings a week). 7 oz. (14 tablespoonfuls) of milk, including that used for porridge.
2 p.m.	1–1½ oz. (2 to 3 tablespoonfuls) of vegetable mash or sieved green vegetables, with gravy or meat juice. 1 small slice of bread and butter (or dripping). 1 oz. (2 tablespoonfuls) of pounded boiled fish (twice a week) from 10 months old. 1½ oz. (3 tablespoonfuls) of milk pudding with a little sugar 4 oz. (8 tablespoonfuls) of milk. a drink of orange juice and water.

6 p.m. — 1 tablespoonful of orange or other fruit juice.
$1\frac{1}{2}$ oz. (3 tablespoonfuls) of cereal or bread and milk.
7 oz. (14 tablespoonfuls) of milk (including that used for the cereal and milk).

10 p.m. — 5 oz. (10 tablespoonfuls) of milk.

Approximately one ounce of sugar should be added to the cereal, fruit, etc. in the above diet.

As the child approaches its First Birthday a little underdone scraped steak or minced meat may be added to the 2 p.m. meal and custard or junket and stewed fruit given instead of milk pudding, as a change.

Diet from One Year to Eighteen Months

(Caloric value approx. 1180 cals., protein 13·8 per cent., fat 37·3 per cent., carbohydrate 48·8 per cent.)

On waking. — Orange juice and water.

8.30 a.m. —
2 oz. (4 tablespoonfuls) of porridge.
A slice of bread fried in bacon-fat or dripping, on alternate days, with one lightly cooked egg.
1 small slice of bread and butter (or dripping).
8 oz. (16 tablespoonfuls) of milk, including that used for porridge.

12.30 p.m. —
1 oz. (2 tablespoonfuls) of finely minced meat, liver, brains or tripe or pounded boiled fish. Vegetable with meat juice or gravy, and a little mashed potato.
1 small slice of bread and butter or dripping.
$1\frac{1}{2}$ oz. (3 tablespoonfuls) of milk pudding or custard, with 1 oz. (2 tablespoonfuls) mashed up stewed apple or prunes, or a little fresh fruit juice.
5 oz. (10 tablespoonfuls) of milk, including that used for the pudding.
A drink of orange juice and water.

5 p.m. —
2 oz. (4 tablespoonfuls) of cereal or bread and milk.
Toast or sponge cake, with a little seedless jam, treacle, honey or mashed banana.
7 oz. (14 tablespoonfuls) of milk including that used for the bread and milk.
A piece of peeled raw apple to chew.

9 p.m. 5 oz. (10 tablespoonfuls) of milk.
(This may be omitted gradually from twelve to fifteen months, and the extra milk given at the other meals.)

Approximately one ounce of sugar should be added to the cereal, fruit, etc. in the above diet.

Children should be given water or orange juice between meals, if thirsty, but nothing else.

All milk should be boiled. Do not give tea, coffee, pastry or sweet cakes. At each of three meals a little toast or baked bread should be given to encourage chewing.

In making up feeds, if possible, use STANDARD MEASURES instead of spoons.

A teaspoonful of cod-liver oil or two teaspoonfuls of cod-liver oil emulsion should be given three times a day.

REFERENCES

K. H. Tallerman and C. K. J. Hamilton, *The Principles of Infant Nutrition and their Practical Application.* (Heinemann (Medical Books) Ltd., 1928, 10*s.*)

Donald Paterson and J. Forest Smith, *Modern Methods of Feeding in Infancy and Childhood.* (Constable, 1935, 7*s.* 6*d.*)

J. V. C. Braithwaite, *Infant Feeding in General Practice.* (John Wright, 1930, 4*s.* 6*d.*)

N. Emslie, *Breast-feeding.* (Oxford Medical Publications, 1931, 5*s.*)

APPENDIX

BREAST MILK

PERCENTAGE COMPOSITION

C.	*P.*	*F.*	*Cals. per z.*
7·5	1·25	3·5	20

MILK MIXTURES FOR GENERAL USE

PERCENTAGE COMPOSITION

	C.	*P.*	*F.*	*Cals. per oz.*
½ cow's milk (milk 1, water 1) .	2·0	2·0	1·75	10
⅔ cow's milk (milk 2, water 1) .	2·7	2·7	2·3	14
Whole cow's milk . . .	4·0	4·0	3·5	20
Half-strength half-cream dried milk	3·2	1·1	·8	7
Full-strength half-cream dried milk	6·4	2·2	1·7	14·3
Full cream dried milk . . .	4·7	3·1	3·3	18·5
Skimmed dried milk . . .	5·3	3·5	0·1	10·5

In the use of any particular brand of dried milk the manufacturers' directions for reconstituting it and their analysis of the composition of the milk should be consulted.

Note.—Cane sugar, or in the case of very young or weakly infants dextri-maltose, must be added to the above to supply the caloric requirement of the child—a minimum of 45 cals. per lb. of body-weight. One drachm sugar per fluid oz. = 12·5 per cent. added carbohydrate or 14 extra cals. per drachm of sugar.

Ounce and drachm weights and measures should be used in preparing the above, the feeding for the whole 24 hours being made up at one time.

CEREAL FOODS

Thin cereal.	C.	*P.*	*F.*	*Cals. per oz.*
⅔ milk + 2·5 per cent. fine oatmeal + 2·5 per cent. sugar. ½ pint of milk 2 parts, water 1 part, with 2 drachms of flour and 2 drachms of sugar added. Make up to ½ pint after cooking with water.	7·7	2·7	2·3	20

Gruel.	*C.*	*P.*	*F.*	*Cals. per oz.*
$\frac{2}{3}$ milk + 4·4 per cent. flour, or fine oatmeal + 5 per cent. sugar + 2·5 per cent. butter. $\frac{1}{2}$ pint of milk 2 parts with 1 part water, with $3\frac{1}{2}$ drachms flour, 4 drachms sugar, and 2 drachms butter. Make up to $\frac{1}{2}$ pint with water.	12·0	2·7	4·3	32
Thick Gruel. (Low in fat.)				
$\frac{1}{2}$ milk + 7 per cent. fine oatmeal + 5 per cent. sugar. $\frac{1}{2}$ pint of milk 1 part, water 1 part, 6 drachms fine oatmeal, 4 drachms sugar. Make up to $\frac{1}{2}$ pint with water.	14·0	2·0	1·75	25
Thick Whole Milk Gruel.				
Whole milk + 7 per cent. fine oatmeal + 5 per cent. sugar. $\frac{1}{2}$ pint of whole milk, 6 drachms fine oatmeal, 4 drachms sugar. Make up to $\frac{1}{2}$ pint with water.	16·0	4·0	3·5	32

Porridge.

$\frac{1}{2}$ pint water + 8 per cent. oatmeal + 3·5 per cent. sugar. To a small quantity of water add 7 drachms fine oatmeal and 3 drachms of sugar. Make into a paste, and then add the rest of the water gradually and stir vigorously while it comes to a boil. Cook slowly for about 20 minutes until it is almost stiff. Pure carbohydrate. The total amount ($\frac{1}{2}$ pint) = 140 cals.

Vegetable Purée.

This is made by well cooking and mashing up (or sieving) carrot, spinach, cabbage, or any green vegetable. Add a knife-point of butter, 1 tablespoonful of gravy or milk. This should be given with a spoon.

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